Title: Man Made Hurricane

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MAN MADE HURRICANE

By Irwin J. Weisenberg, M.E. 1

The wind was roaring past the wings of the little plane as it was tossed and buffeted on its stormy course. Suddenly, after a terrific blast of air, the right wing was ripped from the body and hurled away. No pilot was seen struggling out of the cockpit to jump for his life, and there were no headlines the next day telling of the incident—for this was just a model of a new design being tested in a wind tunnel to make certain that no such accident would ever happen to the finished product. The airflow was cut off and engineers immediately set to work rechecking and redesigning to remove the defect.

Many a test pilot has avoided a crack-up and the cost of many a new ship has been saved by first putting models of the planes under conditions of actual flight before sending the real ship into the air.

To create the same conditions on the ground as in the air, wind tunnels are used. A wind tunnel is simply a long tube, either open at both end or circular, in which is contained a fan to move the air at high speeds, and a support for the model, with suitable instruments attached to determine the reactions of the model to the current of air. Since this gives a close approximation of actual conditions, the engineer can find any errors in design and easily correct them.

There are several types of wind tunnels, each made for a specific purpose. The usual type—a good example of which is the wind tunnel here at Ohio State located in Robinson Laboratory—consists of a circular tube, so that the air, instead of being blown out the front, circles back around and is drawn through the propeller again, giving a smoother and steadier rate of flow.

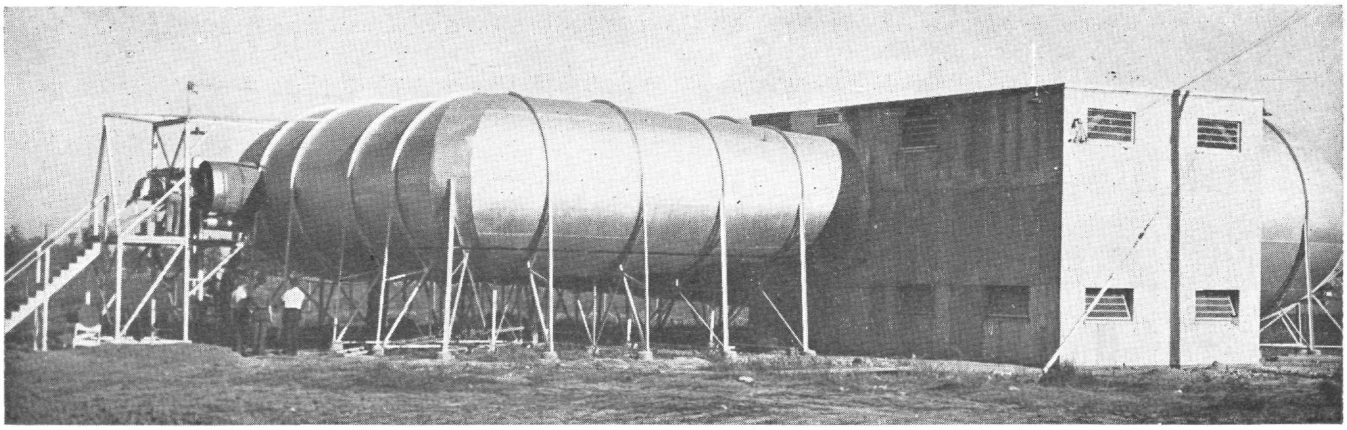
Wind tunnels are constructed of wood, concrete, or steel. The eight year old main tunnel of the National Advisory Committee for Aeronautics at Langley Field, Virginia, is built of structural steel outside, with cement-asbestos sheets forming the inside walls. This tunnel is 434 ft. long and 222 ft. wide. It can test full size planes up to 50 ft. wingspread. The wind speed is much more difficult to regulate in this size tunnel than it is in smaller ones.

A honeycomb is usually placed directly in front of the propellor. This slows down the airspeed slightly but is necessary to smooth out or steady the flow of air. Although even with the honeycomb, the model is placed as close to the fan as possible to insure an even flow.

Vertical or horizontal vanes may be used to direct the air stream. This enables the experimenter to allow the main force of air to flow over different sections of the plane to determine how it reacts to unusual conditions. The vanes also increase the speed of the air slightly.

Sometimes, jets throwing streams of titanium tetrachloride are used. This chemical reacts with moisture in the air, creating a smoke-like substance. The streams of "smoke" are carried along with the air stream and give a visual picture of how the air flows over the parts being tested. Anything on the model that disturbs the flow, thereby decreasing the efficiency, shows up immediately and can be corrected.

The supports and instruments for the model, although they measure the same type of forces, are arranged differently in every wind tunnel due to the conditions present at the time of construction. Some forces that must be measured are air speed, lift, pitch, yaw, and drag. To measure these forces wires or

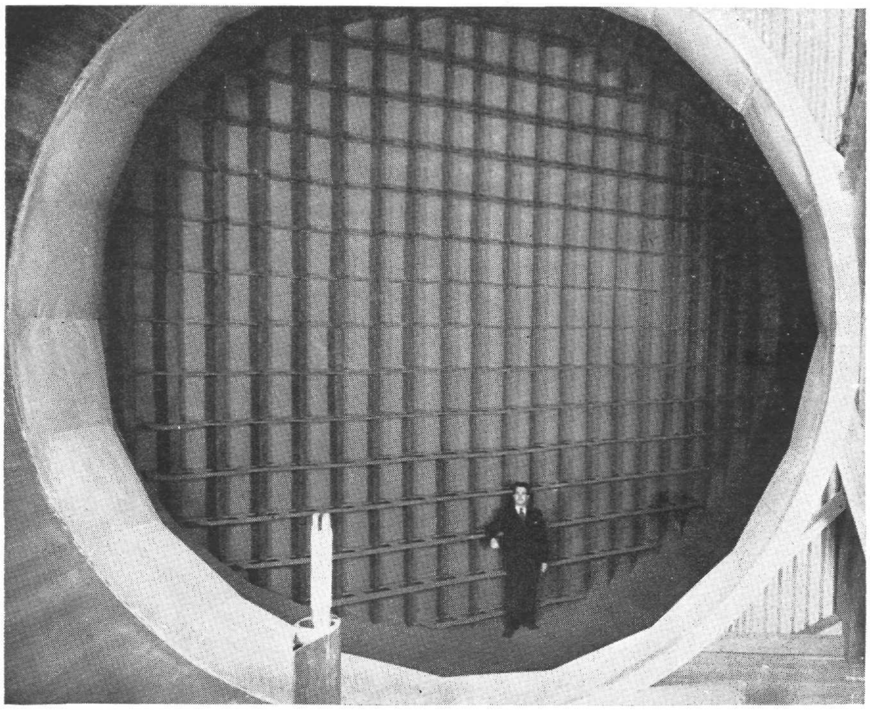


Courtesy—Aviation Magazine.

Exterior View of Wind Tunnel

This picture shows the use of vertical and horizontal vanes to direct the air current against a full-size plane. Note size of tunnel as compared to man.

Courtesy—Aviation Magazine.



linkages connect the model to scales and other instruments. The instruments may be anything from ordinary beam balances to complicated electrical devices. The scales used in the big N.A.C.A. tunnel at Langley Field are large enough to weigh full size airplanes, yet sensitive enough to be used as postage scales. On most wind tunnels the instruments can be locked at any time thus giving the observers a chance to record all settings accurately.

An interesting type is the variable-density wind tunnel. Since the plane must be reduced in order to be tested, the density of the air that supports it must increase as the size decreases to secure the same proportional results per unit area. This effect can be accomplished either by raising the speed, increasing the pressure, or can be eliminated by constructing a tunnel large enough to test the full size airplane. Increasing the pressure has proved to be the most economical method and has given rise to the variable-density wind tunnel. The tunnel is enclosed in a steel plate tank, lapped, and riveted just as a steam boiler. The tunnel of this type at Langley Field is set in a concrete foundation and weighs about 100 tons. Most instruments and controls are on the outside of the tank, but windows are set in the walls to allow the observers to see the model as well as the inside instruments. This tunnel is designed to withstand an internal pressure of 21 atmospheres. The air is compressed in inverse proportion to the model's scale. Thus, if the model is 1/20 the size of the full-scale plane, it is tested under 20 atmospheres.

The first free spinning wind tunnel was developed by the British Royal Aircraft at Farnborough, England in 1932. Every new airplane design built for the British Government is first tested in this tunnel before construction. A similar one is located at Langley Field. The main purpose of this type of tunnel is to study the spinning characteristics of an airplane while it is still in the design stage, thereby eliminating the necessary expense and delay of changes after construction.

The free spinning wind tunnel is vertical instead of horizontal to allow the current of air to support the balsa wood model in free flight. The model is set on a long rod over the center of the tunnel. Its movable controls are adjusted so that they will immediately throw the ship into a spin. The current of air is turned on and gradually increased until it becomes strong enough to support the plane. As soon as the model airplane rises into the air, the pole is withdrawn and spinning begins. The air speed is set to just equal the rate of descent. This vertical velocity of the air represents the rate of descent in a spinning nose dive. Within a second or two a clock-like mechanism inside the fuselage moves the controls into the position of recovery. The model should then recover from the spin and dive into a netting placed below. If it does not, corrections are made and the tests repeated until proper results are secured. During the test a high-speed camera records the entire procedure giving a permanent record that can be studied at leisure for any slight defects that may not have been noticed by the observers during the test.

To study the effects of ice on various parts, refrigeration tunnels have also been built. A wing section is placed inside, the temperature lowered, and ice allowed to form. The location, thickness, and other characteristics of the ice are then closely studied.

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Also new devices for the elimination of ice can be tested in this tunnel.

Many new and important improvements have been developed through the use of wind tunnels. The use of fillets, where fuselage, wings, and engine coverings join each other, thereby increasing the speed to a large extent, have been developed through wind tunnel experimentation. A few other innovations are the N.A.C.A. motor cowling that decreases engine drag by two-thirds, efficient placing of engines in multi-engined craft, counter-sunk rivets which also increase speed, and many others too numerous to mention.

Due to the increase in aircraft production, research has increased considerably. Many universities that have wind tunnels, such as Massachusetts Institute of Technology and California Institute of Technology, are helping the goverment as well as private concerns to solve some of the many aeronautical problems that have arisen. Some factories are even building their own tunnels to speed up design work. The next few years should see many new and unusual wind tunnels springing up all over the country.